

PROCEEDINGS
OF THE
CALIFORNIA ACADEMY OF SCIENCES
FOURTH SERIES

VOL. XVI, No. 7, pp. 159-203, plates 6-12, 3 text figs. APRIL 22, 1927

VII
**EXPEDITION TO GUADALUPE ISLAND, MEXICO,
IN 1922¹**

LAND AND FRESHWATER MOLLUSKS

BY
H. A. PILSBRY
Academy of Natural Sciences of Philadelphia

The exploration of Guadalupe Island was the chief object of the Expedition of the California Academy of Sciences in 1922, but collections were also made at San Quintin Bay, San Martin Island, Cedros Island, the San Benito Islands, Natividad Island, Asuncion Island, Turtle Bay, and Margarita Island and other places around Magdalena Bay. In the following report the mollusks of Guadalupe Island are considered separately from those of the west coast of Lower California and adjacent islands.

I am indebted to Dr. G. Dallas Hanna, in charge of the expedition, and to Dr. Barton Warren Evermann, Director of the Museum, for the opportunity of working up the land and freshwater mollusks collected.

¹ This is paper No. 5 of the *Tecate* Expedition. No. 1, the General Report, gives a complete itinerary. See Vol. XIV, No. 12, pages 217-275, of these Proceedings.

April 22, 1927

GUADALUPE ISLAND²

Guadalupe Island lies 135 miles southwesterly from Point San Antonio, Lower California. It is about 22 miles long, three to six miles wide, and in the northern part rises to an elevation of 4500 feet. There is deep water on all sides; between island and mainland there is a trough over 2000 fathoms in depth. Four miles north of the island, a depth of 1400 fathoms has been found, and about the same distance south over 1100 fathoms. "The summit of Guadalupe is the crest of a gigantic mountain ridge rising over 16,500 feet above its level base on the sea bottom, with only a little more than one-quarter of its height appearing above the surface of the sea."³

The visible structure is volcanic. A large part of the island is arid, but the higher ridges extend into the zone of lower clouds. "Owing to its situation in the midst of cool ocean currents and the prevalence of northwesterly winds, it is much cooler than any part of the coast of Lower California at the same altitude."³ There is considerable frost and cold rain in winter.

The flora and fauna of Guadalupe are rapidly disappearing owing to the introduction of goats, of which there are thousands, and of house mice and cats.

The origin of the Guadalupe fauna and flora is obscure. The land molluscan fauna is not related to that of Lower California and its islands. Its affinities are with the lower group of Channel Islands of California—Santa Barbara, Santa Catalina, San Nicolas and San Clemente islands, and in a smaller degree with the Californian mainland. The details of relationship will be discussed in the descriptive part of the paper. About 78 per cent of the species and subspecies are endemic. The flora, also, is said to be more nearly related to that of California than to the Lower Californian; at least 29 out of 145 species of plants are endemic.

² For a good account of Lower California and its islands see "Lower California and its Natural Resources," by Edward W. Nelson, *Mem. Nat. Acad. Sci.*, Vol. 16, 1922; with many illustrations and an excellent map. Another excellent account, published anonymously but prepared by Carl Beal and associated geologists, is "Informe sobre la exploración geológica de la Baja California, por la 'Marland Oil Company of Mexico,' S. A.," *Boletín del Petróleo*, Vol. 17, No. 6, June, 1924, pp. 417-453, pls. 4-46, map; Vol. 18, No. 1, July, 1924, pp. 14-53, pls. 77-92, geologic map.

³ E. W. Nelson, *loc. cit.*

The direction of the ocean current is favorable for the transport of drift materials from the Channel Islands and Californian coast to Guadalupe; yet at the present time such drift as originates in the Californian islands must be very small stuff. Living snails would have little chance of surviving the voyage to Guadalupe, one would think, and less of making a landfall in a place where land snails could survive. *Xerarionta*, now the dominant snail of the Channel Islands, living on and under bushes and cacti, is lacking on Guadalupe, where all the species appear to be ground snails. There remains the hypothesis that the submarine ridge upon which Guadalupe stands is what remains of a sunken or down-faulted late tertiary peninsula similar to the present peninsula of Lower California, in which case the resemblance of the fauna and flora would be due to former continuity of land. A weighty objection to this hypothesis is the great depth of water over the Guadalupe ridge. Whether this submarine ridge extends to California, I do not know.

Eleven of the 14 species and subspecies of land mollusks known are special to Guadalupe. Grouped by the affinities of the species elsewhere, they fall into three categories, thus:

1. Species either occurring on the California Channel Islands, or most nearly related to species or subspecies only found there; (six genera, eight species).

<i>Micrarionta guadalupiana</i>	<i>Vertigo californica catalinaria</i> ⁵
<i>Haplotrema guadalupensis</i>	<i>Vertigo californica guadalupensis</i>
<i>Binneya guadalupensis</i>	<i>Vertigo degeneris</i>
<i>Succinea guadalupensis</i> ⁴	<i>Sterkia clementina</i> ⁶

2. Species most nearly related to those of the Californian mainland; (two genera, two species).

<i>Helminthoglypta hannai</i>	<i>Striatura milium pugetensis</i> ⁷
<i>Helminthoglypta h. diodon</i>	

3. Species most nearly related to those of the northern coast (San Quintin Bay region in the San Diegan faunal area) of Lower California; (one genus, two species).

<i>Pupilla goniodon</i> .	<i>Pupilla guadalupensis</i>
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⁴ Probably identical with a common fossil *Succinea* of San Clemente Island.

⁵ Identical with a Santa Catalina Island form.

⁶ Identical with a San Clemente form.

⁷ Found on the mainland from San Diego Co., Calif., to Vancouver Island.

Truncatella guadalupensis does not appear more closely related to west coast species than to West Indian. Its nearest affinities are not obvious.

The history of the Guadalupe mollusk fauna goes back about 50 years⁸. The first snails appear to have been collected by Dr. Edward Palmer in 1875. In 1878 W. G. Binney reported the occurrence of *Binneya notabilis*, and in the following year recorded Palmer's other mollusks, *Arionta roswelli* Newc. and *Arionta facta* Newc. He discussed Binneya again, and concluded that the fauna was of Mexican origin.

An unsigned note in Science, 1884, mentioned the finding of *Helix facta* and *Binneya notabilis* by R. G. Dunn, noting the peculiar epiphragm or "hybernaculum" of the latter, and concluded quite correctly that "the fauna and flora of this isolated island are largely southern Californian rather than Mexican."

In 1887 J. G. Cooper commented on the collections of Dunn and others thus: "On Guadalupe Island Mr. W. E. Bryant found a form more like that of the Lower Californian peninsula, once confounded with *H. remondi*. Mr. R. G. Dunn informs me that *H. facta* is also found on Guadalupe Island, and the very peculiar helicoid *Binneya notabilis* has been found there by Mr. Bryant, as well as on the peninsula by Mr. Orcutt."

W. H. Dall, in 1900, described *Epiphragmophora guadelupiana* and *Succinea (rusticana* var.?) *guadelupensis*. The former obviously is the snail previously called "*H. facta*."

H. A. Pilsbry, 1901, described a species of *Truncatella* collected by R. E. Snodgrass.

The earlier authors identified Guadalupe snails with species of the Californian islands and mainland, which they certainly

⁸ The references are as follows:

W. G. Binney: "Terrestrial Mollusks, V," 1878, p. 245. "On the Land Shells of the Mexican Island of Guadalupe, collected by Dr. E. Palmer," Proc. A. N. S. Phila. 1879, p. 16.

Anonymous note on shells collected by R. G. Dunn, Science, Vol. 4, No. 88, Oct. 10, 1884, p. 366. (R. G. Dunn was a collector of seeds who lived in San Francisco to the advanced age of about ninety years. He was considered eccentric, as he apparently preferred gathering seeds to chasing dollars.)

J. G. Cooper: Bull. Cal. Acad. Sci., II, 7, 1887, p. 361.

W. H. Dall: Proc. A. N. S. Phila. 1900, pp. 101-2.

H. A. Pilsbry: Nautilus, XV, 1901, p. 83.

resemble. It cannot be doubted that further exploration of Guadalupe will increase the number of species, although it seems that several are generally distributed over the island.

HELICIDÆ

1. *Micrarionta guadalupiana* (Dall)

Plate 8, figures 1, 1a, 3, 3a, 3b; text fig. 1

Arionta or *Helix facta* Newc., of Binney, Cooper and others.

Epiphragmophora (Micrarionta) guadelupiana DALL,⁹ Proc. A. N. S. Phila. 1900, p. 101, pl. 8, figs. 14, 15 (shell). *E. guadalupiana* DALL, PILSBRY, Proc. A. N. S. Phila. 1898, pp. 68, 71, pl. 1, fig. 11 (genitalia).

Guadalupe Island (Anthony; Snodgrass and Heller). Northeast Anchorage and three miles south of same; Pine Ridge, northwest end of the island, at about 3000 feet elevation; east side two miles north of the South Point (G. D. Hanna).



Fig. 1. *Micrarionta guadalupiana* (Dall). Plesiotypes, Nos. 2557-2559 (C.A.S. Coll.), from three miles south of Northeast Anchorage, Guadalupe Island, Lower California.

This small species, with subcircular, white-lipped aperture appears to be common. The largest shells are from 3 miles south of the Northeast Anchorage, and measure 11.3 to 12.6 mm. diameter. Many of this lot have the spire well elevated and the peripheral angulation weak or subobsolete. Nearly as large ones were taken at Pine Ridge. The lot from Northeast Anchorage, 8 to 10.5 mm. diameter, run smallest and are most distinctly angular.

⁹ The name of this species was originally spelled *guadelupiana*. It appears allowable to emend the name to conform to the recognized orthography of the name of the island, Guadalupe.

In 1898 I published some anatomical details of *E. guadalupiana* from a specimen sent me by Dall for that purpose, not noticing that the species was undescribed at that time. As no details of the shell were given, my premature use of the name should not affect nomenclature.

In Proc. A. N. S. Phila. 1898, p. 68, pl. 1, fig. 11, I described and figured the genitalia of one of the original specimens sent by Dall. As the figure was too small to show the structure plainly, a new one, drawn from the same preparation is given, plate 8, figs. 3, 3*a* (upper part of the female system omitted). The capacious penis passes into a large epiphallus which is continued in a spirally coiled flagellum. The uterus is a very capacious thin-walled sac, the walls longitudinally ridged internally, fig. 3*a*. There is no dart sac visible either outside or within, merely a curved whitish ridge of the integument at the bases of the mucus glands. Both of these are free, as shown in the figure, the descending one club-shaped with rounded end.

The foot, mantle and genitalia are pale chamois-colored. In my original account I stated that the right ocular retractor passed to the left of the genital system; this appears improbable, and may have been an error of observation, but it can not now be confirmed or denied, as the reproductive organs were removed from their place. Length of penis and epiphallus 9 mm., of flagellum 10 mm., of spermatheca and duct 15 mm.

The jaw of this specimen, Pl. 8, fig. 3*b*, has 8 ribs.

In two specimens dissected from near Northeast Anchorage I find the structure different. The foot is dusky on the back, paler on the sides and tail; mantle more or less closely maculate with black. The right ocular retractor passes between penis and female organs as usual. Genitalia, Pl. 8, figs. 1, 1*a*. The penis is costate within and separated from the epiphallus by a perforated partition. Epiphallus about as large as the penis, bearing the retractor muscle, its upper part twisted spirally. The flagellum tapers rapidly and is about equal to the penis and epiphallus in length. The female side bears a well developed dart sac, in the crotch of which the two mucus gland ducts are inserted. The ascending gland (a.m.g.) is long, bulbous at the end, and lies free. The descending gland (d.m.g.) terminates in a *thin, broad collar encircling the entire penis*. The spermatheca is ovate, on a long branchless duct of large caliber.

Length of penis 3 mm.; epiphallus 3.7 mm.; flagellum 6.5 mm. Spermatheca and duct 9 mm. Specimen not killed extended, preserved in alcohol.

In all essential characters this system agrees with that of *M. facta* (Newc.) of Santa Barbara Island, but differs remarkably from that of the paratype of *M. guadalupiana* which I dissected. The specimens of *M. guadalupiana* from Northeast Anchorage had been preserved in alcohol without drowning, and the greater contraction may account for the smaller size of the organs. But the differences in the dart apparatus are not so easily explained. It appears unlikely that there are two species practically alike in shell characters but differing in genitalia, and for the present I incline to the theory that the organs of the paratype of *guadalupiana* which I examined are not mature,¹⁰ or were abnormal. Unfortunately, only three adult examples, from a single station, were preserved in spirit by the 1922 expedition.

For comparison with *M. guadalupiana*, I figure the genitalia of *M. facta* (Newc.), (plate 8, fig. 2, from Santa Barbara Island, No. 99246 A. N. S. P., coll. by H. N. Lowe, July, 1909. The whole animal, when removed from the shell, is chamois-colored, except that there are a few gray spots on the thin lining of the early whorls. The arrangement of mucus glands is exactly as in *M. guadalupiana* from Northeast Anchorage, the ascending one free, the descending spreading in a thin wide collar around the penis. The epiphallus and flagellum are spirally coiled. The right ocular retractor passes between the branches of the genitalia.

2. *Helminthoglypta hannai* Pilsbry, new species

Plate 7, figures 8, 9, 9a, 9b; text figure 2

Shell umbilicate, the width of umbilicus contained about seven times in diameter of shell; depressed, with rounded periphery and low, conoidal spire (or sometimes it is very little raised above the level of the last whorl); dull citrine to olive-lake, with paler streaks and a rather indistinct dusky band above the periphery; the inner whorls having lost the periostracum by wear are walnut brown to burnt umber. The surface is glossy, the early whorls showing fine granulation where

¹⁰ I may mention that I opened a single *M. gabbi* (Newc.) from near Avalon, Santa Catalina, and found the mucus glands as in the paratype of *M. guadalupiana*. The shell was apparently adult; but until more material can be dissected, I do not feel that definite conclusions can be reached.

unworn; on the last whorl this becomes almost effaced (though minute granules may be seen in some places) and it is lightly striate along growth lines. The whorls are moderately convex, the last descending a little in front, rounded basally. The oblique aperture is nearly circular but somewhat wider than high. Peristome thin, narrowly expanded throughout, of a very pale brownish-pink tint, the margins converging, connected by a thin, transparent callus.

Height 13 mm.; diam. 20.6 mm.; $5\frac{1}{3}$ whorls. (Holotype.)

Height 9 mm.; diam. 17.0 mm.; 5 whorls. (Paratype.)

Holotype: No. 2560, *paratype* No. 2561, Mus. Calif. Acad. Sci., from **Pine Ridge, Guadalupe Island, Lower California**, collected by G. D. Hanna, July, 1922, under stones beneath moisture-laden pine trees at an elevation of about 3000 feet and in the zone of much fog.

Two fresh young examples show the sculpture of the embryonic and early neanic whorls. The embryonic shell appears to consist of nearly two whorls, but its limit is not definitely marked. In the youngest example it is densely papillose, the papillæ closely strewn, not in any pattern; towards the end of the first whorl there are some short bristles scattered among the papillæ, these continuing upon the early neanic whorls. In an older individual of about $3\frac{1}{2}$ whorls the papillæ are crescent in some places into smooth radial wrinkles; short bristles appear among them at and beyond the end of the second whorl.

The animal is dark gray to slate color, fading to pale buffy-gray on the tail; coarsely granose.

The right ocular retractor runs between penis and oviduct. The penis is short (3 mm. long), about one-fourth as long as the epiphallus, in the middle of which the very long retractor is inserted. The flagellum is about 6 mm. long. The duct of the spermatheca and its diverticulum are very long (not preserved entire, the animal having been broken in pulling). There is a large dart sac with longitudinally corrugated internal walls. Mucus glands unequal, with reflected ends, both discharging through a single slender duct.

The kidney is $8\frac{1}{2}$ mm. long, pericardium 5 mm. long.

This is doubtless the species mentioned without name by Cooper in 1887, and as *Epiphragmophora* sp. indet. by Dall, Proc. A. N. S. Phila., 1900, p. 102; a single young shell was

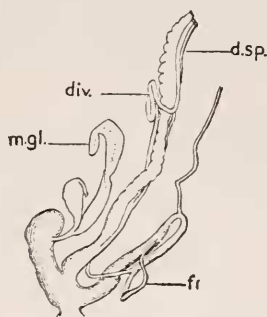


Fig. 2. Genitalia of *Helminthoglypta hannai*, n. sp. See pl. 9, for explanation of letters.

collected by A. W. Anthony in 1896. Presumably it was this species or the following race which Binney called *Arionta rowelli*, and Cooper referred to as like a peninsular species "once confounded with *H. remondi*."

The light greenish glossy shell with a very faint band and a narrow lip is characteristic and quite unlike any known species of the region. The coloration resembles that of some Californian *Helminthoglyptas*, and the reproductive system conforms wholly to that genus, the mucus glands branching from a single duct which enters high on the dart sac. In *Micrarionta* the two mucus glands excrete through separate ducts entering in the crotch between dart sac and vagina.

3. *Helminthoglypta hannai* diodon Pilsbry, new subspecies

Plate 10, figures 23, 24, 25, 26

The shell is similar to *H. hannai* in form and in sculpture so far as this is preserved, the intermediate whorls showing some minute granulation. On the parietal wall a short distance within its limit there are two low oblong callous nodules, their longer axes converging forward at approximately somewhat more than a right angle, but usually not meeting; the

inner nodule stands close to or united with the columella, the outer one being near the suture.

Height 13.0 mm.; diam. 21.5 mm.; $5\frac{2}{3}$ whorls. (Holotype.)

Height 11.4 mm.; diam. 20.0 mm.; $5\frac{1}{2}$ whorls.

The largest and smallest adult shells have diameters of 22 and 17.5 mm.

Holotype: No. 2562, *paratypes* Nos. 2563-2565, Mus. Calif. Acad. Sci., from **Northeast Anchorage, Guadalupe Island, Lower California**, collected by G. D. Hanna, July, 1922.

The nodules of the parietal wall are shaped and situated exactly as in *Sonorella dalli* Bartsch and *S. parva* Pils.¹¹ Elsewhere, somewhat similar "teeth" occur in the Chinese group *Metodontia*.

In a few individuals the two nodules are weakly connected, forming a bow, thus (; and in a few others they are obsolete in apparently mature or nearly mature shells. Although considerable search was made for living snails, only old dead shells were found.

HAPLOTREMATIDÆ

4. *Haplotrema guadalupensis* Pilsbry, new species

Plate 7, figures 7, 7a

The shell resembles *Haplotrema catalinensis* (Hemphill),¹² being small, depressed, whitish, with, on the last whorl retractively radial, low and weak striæ, locally distinct but mainly more or less effaced; differing from that species by the smaller size with rounder, less depressed whorls and a cordate aperture less excised by the preceding whorl and nearly as high as wide; (in *H. catalinensis* the aperture is much wider than high). The umbilicus is very broadly open. The lip is thin but smoothly finished, the upper margin slightly straightened.

Height 2.25 mm.; diam. 4.9 mm.; width of umbilicus 1.8 mm.; $3\frac{1}{2}$ whorls. (Holotype.) Height 2 mm.; diam. 4.7 mm. (Paratype.)

¹¹ Proc. A. N. S. Phila., Vol. 75, 1923, p. 92.

¹² *Selenites duranti* var. *catalinensis* Hemphill in W. G. Binney, Bull. Mus. Comp. Zool. XIX, No. 4, 1890, p. 221; XXII, No. 4, 1892, p. 165, pl. 2, fig. 3.

Holotype: No. 2652, *paratype* No. 2653, Mus. Calif. Acad. Sci., from **Pine Ridge, Guadalupe Island, Lower California**; elevation about 3000 feet; collected by G. D. Hanna.

This species belongs to the typical group of *Haplotrema*, the large continental species forming the new subgenus *Geomene*, type, *Helix concava* Say.

ZONITIDÆ

5. *Striatura milium pugetensis* (Dall)

Patulastra? (*Punctum?*) *pugetensis* DALL, Nautilus, VIII, 1895, p. 130.

In this form the initial whorl shows strong spiral striation. Described from near Seattle, Washington, it has since been found in several places on Vancouver Island (C. Montague Cooke, A. W. Hanham), in Oregon (John A. Allen), in the San Bernardino Mountains, San Bernardino Co., California (S. S. Berry), and in San Diego Co. at Ballena (Hemphill) and the Palomar Mountains (Joshua L. Baily, Jr.). It appears to be widely spread on the Pacific slope, and will doubtless be found in many places when leaf-sifting becomes more general.

The Guadalupe Island specimens are entirely similar to those of California. They were found in the hills about 1000 feet above Northeast Anchorage and on the east side of the island about two miles north of the south end; G. D. Hanna, coll.

ARIONIDÆ

6. *Binneya guadalupensis* Pilsbry, new species

Plate 6, figures 2-9; plate 9, figures 2, 2a, 2b, 2c, 2d, 3

Binneya notabilis of the Guadalupe lists of Binney, Cooper and others.

The shell is more convex than *B. notabilis*, the convexity one-third of the length; on the ventral side there appears a larger crescent of the latero-basal wall; the furrows between spiral cords of the first whorl are transversely costulate, and the adjacent part of the post-embryonic whorl is rather sharply striate along the lines of growth.

Length 9.5 mm.; width 6.6 mm.; convexity 3.2 mm.

Length 12 mm.; convexity 4.1 mm.

Syntypes: Nos. 2566-2573, Mus. Calif. Acad. Sci., from **three miles south of Northeast Anchorage; Pine Ridge**, elevation, 3000 feet; and **two miles north of southern end of Guadalupe Island, Lower California**; collected by G. D. Hanna, 1922.

This is doubtless the snail which has repeatedly been reported from Guadalupe as *Binneya notabilis*. Comparison with a good series of *B. notabilis* from Santa Barbara Island shows that the Guadalupe form is quite distinct specifically by characters of shell, genitalia and, less significantly, of jaw. It seems to be abundant, generally spread over the island and cruelly preyed upon by the feral house mouse.¹³

A drowned individual dissected has a foot length of 20 mm., mantle length 11 mm. The pedal furrow is well impressed, and there is an irregular, impressed line above it. Spaced grooves radiate from the mantle, connected by sparse reticulation. The mantle is quite narrowly reflected over the edges of the shell, and is produced in a broad body-lobe in front; buff, maculate with black. Pneumostome large, behind the middle. The body is pale buff, maculate with dark gray, the maculae more or less noticeably arranged in radial order, wanting on the tail, the face and back gray, not maculate. The tail is concave below the back of the shell, elsewhere rounded above. The sole is pale buff, distinctly tripartite by impressed lines. Alcoholic specimens are figured, Pl. 6, figs. 7, 8, 9.

Genitalia, Pl. 9, figs. 2-2*d*. The genital orifice is below and behind the right ocular tentacle, the retractor muscle of which passes between penis and oviduct. The penis is well developed, with terminal retractor inserted on the diaphragm and arises a short distance from the end of penis. The epiphallus is much longer than the latter. There is an enormous atrium plus vagina, its thin walls corrugated internally in places. When cut open, as in Pl. 9, fig. 2*b*, it is found to contain a large conic body 9 mm. long, one side of which forms a compressed wing which coils partly around the main body, as in figs. 2*b*, 2*c*. The wing is wanting in the distal third. It is composed of a cylindrical cone of hard circular muscles, surrounded by a layer of spongy tissue, which is minutely, closely and superficially fissured externally in a circular direction. It is perforated by the oviduct, the perforation stelliform in sec-

¹³ Cf. Hanna, Proc. Calif. Acad. Sci. XIV, No. 12, p. 228.

tion.¹⁴ The spermatheca is irregularly ovate on a rather short duct which enters about at the upper third of the atrial sac.

The jaw, Pl. 9, fig. 3, has eight strong ribs projecting slightly at the margins, the ends free from ribs.

The genitalia of this species differ widely from Binney's description and figure of those organs in *Binneya notabilis*, but I have not been able to obtain that species in the flesh for direct comparison. There is no reason to believe that Binney's figure is far wrong, but the Santa Barbara Island species ought to be dissected again to confirm its characters, and especially to determine the internal structure of the lower ducts of the female side, which Binney did not open.

The external characters of the animal are about the same in the two species, also the general character of the jaw (8-ribbed in *B. guadalupensis*, 6-ribbed in *B. notabilis*) and the peculiarly extended papery epiphragm, shown in Pl. 6, figs. 3, 6.

W. G. Binney¹⁵ expressed the opinion that the Mexican genus *Xanthonyx* was identical with *Binneya*. At one time I accepted this synonymy,¹⁶ but subsequently¹⁷ the relationship of *Xanthonyx* to the *Helicidæ* was recognized. It has nothing to do with *Binneya*. *Binneya* is not a "Mexican genus" as stated by Binney. It is known from Santa Barbara and Guadalupe islands only.

SUCCINEIDÆ

7. *Succinea guadalupensis* Dall

Succinea (rusticana Gld. var.?) *guadalupensis* DALL,¹⁸ Proc. A. N. S. Phila. 1900, p. 102, pl. 8, fig. 12.

Only a fragment obtained; Guadalupe Island: Pine Ridge, about 3000 feet elevation (G. D. Hanna). This form appears indistinguishable from shells of San Clemente and San Nicolas

¹⁴ This large muscular terminal part of the oviduct may possibly function as an organ of copulation, analogous to the condition existing in some other *Arionidæ*, but in the absence of a retractor muscle this is doubtful.

¹⁵ Terr. Moll. U. S. Vol. V, 1878, p. 245.

¹⁶ Proc. A. N. S. Phila. 1898, p. 229.

¹⁷ Proc. Malac. Soc. London, IV, 1900, p. 27.

¹⁸ As in the case of *Micrarionta guadalupiana*, I emend the name "guadalupensis." To perpetuate an inadvertent wrong spelling of a geographic unit which has never had but one orthography seems to me pedantic, although in general I adhere to the original spelling of a specific name.

islands which generally have gone under the name *S. avara* Say. It is a very difficult group; and while I doubt whether the Guadalupe Island form is a distinct species, not much can be said until fresh shells come to hand.

PUPILLIDÆ

8. *Pupilla goniodon* Pilsbry, new species

Plate 7, figure 3

The shell resembles *P. sterkiana* of the Lower Californian mainland in shape and sculpture. It is thin, cylindric, with blunt, rounded ends, cinnamon colored, with sculpture of strongly retractive, widely spaced riblets, which are more or less irregular or in places dislocated, sometimes with short, twig-like branches; they are about one-fourth as wide as their intervals or less. The initial $1\frac{1}{2}$ whorls have irregularly anastomosing net-like sculpture and pale grayish color. Subsequent whorls are moderately convex, and the last one rises somewhat and becomes flattened laterally towards the aperture. The aperture is about as wide as long, somewhat squarish with rounded angles. The peristome is expanded, the outer and basal margins thickened with a cinnamon callus within, upper external margin thin; columellar margin dilated. There is a transverse white nodule on the parietal wall within the angle of the lip, united with the latter, and continued in a thin callus across to the columellar lip-insertion. Length, 4 mm.; diam., 1.9 mm.; $6\frac{3}{4}$ whorls.

Holotype: No. 2574, Mus. Calif. Acad. Sci., from **Northeast Anchorage, Guadalupe Island, Lower California**; collected by G. D. Hanna at an elevation not greater than 100 feet, in the cañon back of the buildings; abundant.

The presence of a strong angular nodule and the more delicate riblets differentiate this species from *P. sterkiana*. In exceptional specimens there is the barely perceptible trace of a parietal tooth, rather deep within; in none do I see any columellar tooth or truncation, such as *P. sterkiana* usually shows in an oblique view in the aperture. The species was collected alive in some numbers.

9. *Pupilla guadalupensis* Pilsbry, new species

Plate 7, figures 1, 2

Shell cylindroid, slowly tapering in the upper half, cinnamon colored, only slightly glossy, very evenly sculptured with retractive riblets paler than the ground color, from a half to a third as wide as their intervals and about 14 to 16 in one millimeter on the face of the last and penult whorls; the usually paler $1\frac{1}{2}$ embryonic whorls have the net-pitted sculpture of *Striopupilla*. Subsequent whorls are rather strongly convex. Aperture rounded below, straightened with rounded angles above; no trace of a crest or contraction behind outer lip. Peristome expanded, heavily thickened within except at the posterior-lateral curve, continuous in a slightly free or adnate callus across the parietal wall. Aperture typically four-toothed: angular lamella in form of a callous pad within the posterior angle, parietal lamella short, stout, deeply placed, columellar lamella low and broad, palatal fold a rounded, deeply placed tubercle. (Other forms of the species may lack all but the angular pad.)

Length 2.8 mm.; diam. 1.5 mm.; $5\frac{1}{2}$ whorls. (Holotype.)

Length 3.1 mm.; diam. 1.5 mm.; $5\frac{3}{4}$ whorls.

Holotype: No. 2575, *paratypes* Nos. 2576-2578, Mus. Calif. Acad. Sci., from **Guadalupe Island, Lower California**, 1000 feet above Northeast Anchorage; *paratypes*: Nos. 2579-2580 from two miles north of south end of island on east side; G. D. Hanna, Coll. The species was also found near sea level at Northeast Anchorage and on the crest of Pine Ridge at an elevation of 3000 feet.

The close, regular, evenly developed ribs distinguish this species from other American *Pupillæ*, the other two species of the subgenus *Striopupilla* having the ribs more uneven and more widely spaced. It resembles the Asiatic *Pupilla annandalei*, which, however, belongs to a different subgenus.

As in most species of this genus, the parietal, columellar and especially the palatal teeth are variable, either present or absent. The angular pad appears in all adult individuals, and is sometimes the only tooth present, as in fig. 2. The four-toothed form, selected as typical on account of its status as the

most primitive form, is exceptional in some lots seen, but common in other lots.

Five specimens taken at random from the type lot have teeth as follows:

1. Angular, parietal, columellar, palatal.
2. Angular, parietal, columellar, palatal.
3. Angular, parietal,
4. Angular, columellar,
5. Angular,

In No. 2 the parietal is very small; in No. 4 the columellar can be seen only in an oblique view in the aperture.

A similarly unselected lot of ten, from two miles north of the south end of the island, has teeth as follows:

1. Angular, parietal, columellar, palatal.
2. Angular, parietal, columellar, palatal.
3. Angular, parietal, columellar, palatal.¹⁹
4. Angular, columellar, palatal.
5. Angular, parietal, columellar,
6. Angular, parietal, columellar,
7. Angular, parietal¹⁹ columellar,
8. Angular, parietal, palatal.
9. Angular, parietal,
10. Angular,

10. *Vertigo californica catalinaria* (Sterki)

Plate 7, figure 5

Man. Conch. XXV, 1919, p. 142, pl. 9, figs. 5, 6.

The specimens are darker than the Catalina Island form, but no other difference was detected. There is some variation in diameter among them, also in the spacing of the ribs, the specimen figured having them more widely spaced than some others. Very few are fresh, most being dead shells, so fragile that they cannot be cleaned. Length 1.95 mm.; diam. 1 mm. The species was found generally distributed by Dr. Hanna: At Northeast Anchorage and 1000 feet above; and two miles north of the south end on the east side.

¹⁹ This tooth is very small.

11. *Vertigo californica guadalupensis* Pilsbry, new subspecies

Plate 7, figure 4

The differential characters of this form are that it possesses a distinctly developed angular lamella standing about midway of the length of the long parietal lamella, and the striation is quite fine, there being about 30 striæ in 1 mm. on the face of the last whorl. Length 2 mm.; diam. 1.1 mm.

Holotype: No. 2582, Mus. Calif. Acad. Sci., from **Guadalupe Island, Lower California**; collected about 1000 feet above the landing at Northeast Anchorage by G. D. Hanna.

In most groups of *Vertigo* the presence or absence of an angular lamella has little significance, but in the *V. californica* group I have never seen this lamella in hundreds of shells examined. However, Dr. V. Sterki has mentioned seeing "traces" of an angular lamella in some specimens of *V. californica*, which is a larger, more coarsely sculptured form than *V. c. guadalupensis*. I have thought it best to name this island form in order to stimulate the attention of future collectors. It was found associated with *V. c. catalinaria*.

12. *Vertigo degeneris* Pilsbry, new species

Plate 7, figure 6

The oblong, brown shell tapers from the last whorl to the obtuse apex. The whorls are strongly convex, *almost smooth*, but on the penult whorl some spaced wrinkles along growth lines are noticeable; though weak, they evidently correspond to the riblets of *V. californica*. The rounded aperture has no teeth. Columella concave, the columellar lip being rather broadly expanded. Length 1.9 mm.; diam. 1.1 mm.; $4\frac{1}{2}$ whorls.

Holotype: No. 2583, *paratypes* Nos. 2584, 2585, Mus. Calif. Acad. Sci., from **Guadalupe Island, Lower California**; collected about 1000 feet above the landing at Northeast Anchorage by G. D. Hanna.

A strongly characterized form, which, however, may prove to be connected with a similarly toothless form found at Northeast Anchorage, in which the riblets are well developed.

April 22, 1927

Length 1.8 mm.; diam. 1.1 mm. As only broken examples of this ribbed form were taken, its status is left in suspense for the present.

13. *Sterkia clementina* (Sterki)

Man. Conch. XXVI, p. 54, pl. 7, figs. 9, 10, 13.

A single specimen taken at Northeast Anchorage, Guadalupe Island (G. D. Hanna), in which the whorls are a trifle less convex than in a San Clemente cotype, but the difference is so small that no separation of the forms appears feasible.

TRUNCATELLIDÆ

14. *Truncatella guadalupensis* Pilsbry

Plate 7, figure 11

Truncatella stimpsoni guadalupensis PILSBRY, Nautilus XV, Nov., 1901, p. 83.

The subcylindric shell tapers slowly to the truncate summit and is pinkish-cinnamon colored on the last whorl, fading on those above. The whorls are rather weakly convex, the suture not deeply impressed. Sculpture of moderately strong vertical ribs, weaker or partially effaced on the convexity of the last whorl. There is a strong, rounded rib or crest close behind the outer and basal lip margins. The aperture is ovate, the lip expanding a little. Length 6.5 mm.; diam. including outer lip 2.6 mm.; above aperture 2.5 mm.; $4\frac{1}{2}$ whorls.

Guadalupe Island: Type and paratype No. 81973 A. N. S. P., collected by R. E. Snodgrass, November, 1899.

I formerly ranked this form as a subspecies of *T. stimpsoni* Stearns, but having compared long series of all the west coast species, *T. californica* Pfr., *T. stimpsoni* Stearns and *T. bairdiana* C. B. Ad., I consider the Guadalupe form quite distinct, not closely related to any of them. It is stouter in figure than *T. stimpsoni* figured for comparison in Pl. 7, figs. 10, 12-14; the sutural region is not excavated as in that species; the ribs are not so prominent, and in a face view the last whorl is seen to be longer relative to the length of the shell, occupying more

than half of the total length, while in *T. stimpsoni* it is decidedly less.

This species was not obtained by the expedition of 1922. Just where on the coast Mr. Snodgrass picked it up was not recorded.

LOWER CALIFORNIAN WEST COAST AND ADJACENT ISLANDS

HELICIDÆ

All of the Lower Californian Helicidæ appear to belong to the genus *Micrarionta*. The capacious coastal and insular species form the subgenus *Xerarionta*.²⁰ The depressed, smoothish, umbilicate forms,²¹ largely of the interior, are left in the typical section of *Micrarionta*; none of them is known anatomically, but I share the doubt expressed by Hanna²² as to the propriety of my former reference of these species to *Sonorella*. They do not have the special apical sculpture of the California-Arizona subgenus *Eremarionta*.

C. R. Orcutt²³ has published his opinion that Margarita Island was the type locality of *Helix pandoræ*, *H. levis* and *H. areolata*; also that these together with *H. veatchii* are varieties of a single species. Not having seen his material I should perhaps express no opinion on it, but some hundreds of shells from Margarita Island and its vicinity which I have examined lead me to deny the existence on that island of any snails properly referable to *Micrarionta pandoræ*, *levis* or *veatchii*, whether these are considered distinct species or mere varieties. There are on Margarita Island several forms or varieties of *M. areolata*. Whether all of the *Xerariontas* of this coast are referable to one species or several is merely a matter of individual judgment in appraising their characters, and in the amplitude allowed to the species concept, admitted to be conventional.

²⁰ These forms were described and figured by Pilsbry in Proc. A. N. S. Phila. 1913, pp. 380-393, plates 15, 16, and Hanna, Proc. Calif. Acad. Sci. (4), XII, p. 505.

²¹ Described and partly figured under the generic name *Sonorella*, Nautilus XXIX, 1916, pp. 97-101, plate 2.

²² Proc. Calif. Acad. Sci. (4), XII, No. 26, 1923, p. 504.

²³ Nautilus XXXII, 1918, pp. 55-58.

15. *Micrarionta stearnsiana* (Gabb)

West shore of San Quintin Bay and on San Martin Island (G. D. Hanna).

"Three species of land shells were very common among brush thickets on the west side [of San Quintin Bay], the most noticeable being the large *M. stearnsiana*" (Hanna; 1925).

San Martin Island, lying a few miles northwest of San Quintin Bay, is wholly covered with lava.

16. *Micrarionta canescens* (Adams & Reeve)

Plate 11, figures 6-10

Proc. A. N. S. Phila. 1913, p. 386, fig. 1a-d (South Bay, Cedros I., H. N. Lowe); also pl. 15, fig. 12 (Natividad I.).

Cedros Island, west side, near the Red Rocks; also Bernstein's Spring at about 2000 ft. elevation on desert plants (G. D. Hanna). Natividad Island on the north side below first giant cactus (G. D. Hanna). On the mainland at Turtle Bay, south side, (G. D. H. and E. K. Jordan) and north side of same bay (G. D. H. and A. W. Anthony).

There appears to be no tangible difference between Cedros Island and Turtle Bay specimens. All of the lots are individually quite variable in size, degree of elevation, development of spiral sculpture and amount of banding. There is often the barely discernible trace of a columellar tooth, sometimes a distinct but very small one, and more often none whatever. In the lot from Natividad Island, none shows the columellar tooth. One from this place was figured as a form of *M. veatchii* in Proc. A. N. S. Phila. 1913, pl. 15, fig. 12.

Specimens from near Red Rocks (Pl. 11, figs. 7-10) and from the north side of Turtle Bay (Pl. 11, fig. 6) are figured.

17. *Micrarionta canescens veatchii* ('Newc.' Tryon)

Plate 11, figures 11-15

Micrarionta veatchii PILSBRY, Proc. A. N. S. Phila. 1913, p. 384, pl. 15, fig. 1-7, 10, 13-16.

Cedros Island: north end near the old mine; "Grand Canyon," near center of east side of island; Bernstein's Camp; South Bay (G. D. Hanna).

This well-known race differs from *M. canescens* by the generally more ample shell, typically with a higher spire and more expanded lip; it never has any trace of a columellar tooth. As it seems generally distinguishable from the more widely distributed *M. canescens* it may perhaps be allowed subspecific rank. It occurs only on Cedros Island.

Specimens from the old mine and the "Grand Canyon," and two labelled South Bay (Pl. 11, figs. 14, 15) are typical *veatchii*. Those from Bernstein's Camp are nearly all more depressed, some typically colored, others with the coloration of the variety *leucanthea*; three are figured, Pl. 11, figs. 11-13.

18. *Micrarionta pandoræ* (Forbes)

Plate 10, figures 1-16

Proc. A. N. S. Phila. 1913, p. 382.

East Benito Island; West Benito Island, living in abundance in the rock slides; on the north side, northeast point and south side (G. D. Hanna).

Large series were taken. While everywhere variable in color, there is less variation in form than in related species; and such local differentiation as exists is a matter of relative numbers of the various color-patterns in the several colonies. In the lot from East Benito (Pl. 10, figs. 1-9) bicolored and banded forms predominate, those of a nearly uniform shade being rare. A lot from the northeast corner of West Benito is similar. A small lot from the south side of West Benito (Pl. 10, figs. 10-12) contains 13 of vinaceous fawn color, nearly uniform or with an ill-defined band, or with strewn dusky spots, and four with lighter, banded base. A lot from the north side (Pl. 10, figs. 13-16) contains similar patterns, with also white, bicolored and nearly black specimens. A color plate would be needed for an adequate exposition of the color patterns of *M. pandoræ*.

19. *Micrarionta levis* (Pfr.)

Proc. A. N. S. Phila. 1913, p. 387.

Turtle Bay, Lower California, south side, (G. D. Hanna and E. K. Jordan); north side of same (G. D. H. and A. W. Anthony). Asuncion Island (G. D. H.).

The specimens are similar to pl. 16, figs. 42, 43 of my paper of 1913. On Asuncion Island Dr. Hanna states that specimens were scarce and semifossilized; no live ones were found. Columellar tooth is usually well developed but sometimes obsolete.

20. *Micrarionta levis crassula* (Dall)

Plate 10, figures 17-22

Epiphragmophora crassula DALL, Proc. A. N. S. Phila. 1900, p. 100, pl. 8, fig. 3.

Micrarionta levis var. *crassula* DALL, PILSBRY, Proc. A. N. S. Phila. 1913, p. 389, pl. 15, fig. 24.

Natividad Island; dead shells were everywhere in abundance, but not a live one could be found (G. D. Hanna).

All of the specimens yet found have the appearance of fossils, and have certainly been dead a long time. Most specimens are filled with sand, and have the appearance of being etched by blowing sand or worn by rolling. It appears to be extinct. The series of over 80 collected by the expedition of 1922 shows it to be rather variable as in Pl. 10, figs. 17-22, showing normal and extreme forms. There seem to be no constant characters to separate this Natividad Island form from mainland *M. levis*, and the subspecific rank gives too much importance to the Natividad form.

Height 17.0, diam. 20.7 mm.; $5\frac{1}{3}$ whorls.

Height 18.0, diam. 18.8 mm.; $5\frac{1}{2}$ whorls.

Height 15.7, diam. 18.0 mm.; $5\frac{1}{3}$ whorls.

Height 12.0, diam. 15.5 mm.; $4\frac{1}{2}$ whorls.

Height 11.3, diam. 15 mm.; 5 whorls.

21. *Micrarionta areolata* (Pfeiffer)

Plate 6, figure 10; plate 11, figures 1-5; plate 9, figures 1, 1a, 1b

PILSBRY, Proc. A. N. S. Phila. 1913, p. 390.—ORCUTT, Nautilus XXXIII, 1918, p. 55.

Magdalena Island near the village of Magdalena Bay; ocean beach, Magdalena Bay; Margarita Island, southern division; all collected by G. D. Hanna, July, 1922.

A series from the first locality mentioned consists of specimens having narrow, interrupted vandyke-brown bands, and agreeing exactly with Pfeiffer's figures.²⁴ Probably this was the type locality. With them are others with the bands reduced, and also white, bandless shells (figs. 2-5).

The series from Margarita Island, south division (fig. 1), consists of 31 white shells, and 5 with small remnants of brown spot-bands, chiefly on the spire. Two measure:

Height 22.0; diam. 26.5 mm.; $5\frac{1}{2}$ whorls.

Height 19.5; diam. 22.0 mm.; $5\frac{1}{3}$ whorls.

A lot from the sand dunes on the ocean across from Magdalena Bay Village consists of thin, small shells, 19 to 21 mm. in diameter, white with very pale brown to ivory yellow spot-bands or tessellation, or uniform white. One of the lot measures 25 mm. in diameter.

One of the fine specimens of typical *areolata* from near the village of Magdalena Bay was dissected and the genitalia figured, Pl. 9, figs. 1, 1a, 1b. The epiphallus (*epi.*) is as large in diameter as the penis and much longer; it bears the penial retractor. The flagellum is coiled (fig. 1b, *fl.*). The descending mucus gland (figs. 1, 1a, *d.m.g.*) is spread out over the base of the dart sac (*d.s.*) and vagina, the ascending one (fig. 1, *a.m.g.*) spreads on the upper part of the dart sac. The diverticulum of the spermathecal duct (fig. 1, *div.*) is very long and larger than the branch bearing the spermatheca. Length of penis 7 mm.; epiphallus 13 mm.; flagellum 40 mm. Length of spermatheca and duct 40 mm.; of diverticulum 28 mm.

The pallial organs are photographed in Pl. 6, fig. 10. The kidney is less than half as long as the lung, more than twice the length of the pericardium. The principal vein has numerous large branches anteriorly. Length of lung 33 mm.; of pericardium 5.5 mm.; of kidney 14 mm.

In 1898 I published²⁵ figures of the genitalia of several Lower Californian Xerariontas. The forms dissected from the San Benitos, Cedros and further south are much alike, dif-

²⁴ Reproduced by me in Proc. A. N. S. Phila. 1913, p. 390, figs. 2a, b, c.

²⁵ Proc. A. N. S. Phila., 1898, p. 68, pl. 1.

fering from *M. stearnsiana* of the San Diegan faunal area by having the descending mucus gland spread upon dart sac and vagina instead of on the penis. The flagellum and the diverticulum of the spermathecal duct are very long.

22. *Micrarionta evermanni* Pilsbry, new species

Plate 12, figures 4, 5, 6

Shell depressed, with low spire, rounded periphery and umbilicate base, the umbilicus contained nearly seven times in the diameter. Color unknown, as the specimens are bleached (fossil?), but a faintly sketched narrow dark band revolves above the periphery. The surface of the first whorl shows some weak irregular radial rugæ; subsequent whorls are marked with light growth lines, otherwise smooth. The whorls increase rather slowly to the last, which expands to more than twice the width of the penult; it descends rather deeply to the aperture. The aperture is strongly oblique, very shortly oval, the outer margin rather conspicuously expanded, basal margin subreflected, columellar margin dilated and covering a small part of the umbilicus. Height 12.7 mm.; diam. 22.3 mm.; aperture 11.3x13.5 mm.; umbilicus $3\frac{1}{3}$ mm.; 5 whorls; holotype, No. 2618. Height 11.7 mm.; diam. 19.7 mm.; $4\frac{3}{4}$ whorls; paratype, No. 2619.

Holotype: No. 2618, *paratypes* Nos. 2619, 2620, Mus. Calif. Acad. Sci., from north side of **Turtle Bay, Lower California**, collected by G. D. Hanna and E. K. Jordan, June, 1925. Found among loose rocks in an outcrop of Pliocene gravelly strata about $1\frac{1}{2}$ miles north of the bay shore and across the valley to the west of the white Miocene exposures.

This species is probably most nearly related to *M. merrilli* (Bartsch), described from below San Quintin, Lower California, but it differs by the larger aperture and the well expanded peristome, in these characters approaching *M. lohrii* (Gabb) somewhat.

The sculpture of the embryonic whorl is not well preserved, but such as there is resembles that of *M. lohrii*. These So-

morella-like Lower Californian species do not have the embryonic sculpture of the Californian desert *Micrarionta* of the subgenus *Eremarionta*, and they apparently belong to the typical section of *Micrarionta*, which is otherwise insular in distribution. To definitely fix their systematic position the dissection of some member of the group is desirable.

BULIMULIDÆ

23. *Bulimulus hannai* Pilsbry, new species

Plate 11, figures 16-20; plate 12, figure 3

B[ulimulus] striatulus DALL, HANNA, Proc. Calif. Acad. Sci. (4) XII, No. 26, 1923, pp. 486, 487. Not *B. pallidior* var. *striatulus* DALL.

The shell has a very ample umbilicus and ovate-conic shape; it is rather thin, light pinkish cinnamon with shreds of more yellowish, clay-colored periostracum. The conic spire is rather slender above. The initial whorls are strongly convex and delicately costulate as in related species; subsequent whorls are moderately convex, with very slight, retractive striation, and on the last one (to three) there are very delicate spiral threads which may be minutely beaded where well preserved (Pl. 12, fig. 3). The ovate, somewhat oblique aperture is carried well forward to the ventral convexity of the last whorl; it is colored inside like the exterior. The peristome is thin, moderately expanded, the margins connected by a short parietal callus. The columella is straightened but not plicate above, and very broad in an oblique view in the aperture. The internal axis (fig. 18) is large.

Length 38.5 mm.; diam. 22.7 mm.; length aperture 22.8 mm.; $6\frac{1}{2}$ whorls.
Length 33.2 mm.; diam. 20.5 mm.; length aperture 20.5 mm.; $5\frac{2}{3}$ whorls.
Length 31.0 mm.; diam. 20.0 mm.; length aperture 18.0 mm.; $5\frac{2}{3}$ whorls
(Type).

Holotype: No. 2621, *paratypes* Nos. 2622-2625, Mus. Calif. Acad. Sci., from Margarita Island in Magdalena Bay, Lower California; collected by G. D. Hanna under stones within one

mile, west and south, of the village near the center of the east side of the island.

B. pallidior (Sowb.) is more oblong, less acutely conic, the initial whorl larger and lower, the aperture is less oblique, with a more expanded lip, which is somewhat thickened within; the umbilicus is less ample within than in *B. hannai*, not penetrating as deep. In a specimen cut open from the back the axis is much smaller in *B. pallidior* than in *B. hannai*. All of the specimens of *B. pallidior* seen are white. In forms of *B. pallidior* which show granulation, it is of an entirely different character. In *B. hannai* the spiral threads are very narrow, widely spaced and usually in places show very beautiful minute beading, but more often they are almost or even completely effaced.

Two examples of *B. hannai* from Magdalena Island 4 miles south of the village of Magdalena Bay, collected by Hanna, have the spiral threads more strongly developed than in Margarita Island shells, though still very small.

B. hannai appears to be one of the most distinct species of its group, but since it has been confused with *B. pallidior striatulus*, some account of that race is required. This is the more essential because *striatulus* was only briefly defined, and the localities assigned seem to be incorrect or dubious.

24. *Bulimulus pallidior striatulus* Dall

Plate 12, figures 1, 7, 8

[*Bulimulus pallidior* var.] *striatulus* DALL, Proc. U. S. Nat. Mus. XVI, 1893, p. 640.

This variety was defined as follows:

"The spiral striation in many specimens [of *B. pallidior*] becomes pronounced, and in some reaches a point comparable to the surface of the *B. montezuma*. For this variety I have used the varietal name *striatulus*. It is particularly noticeable in collections from Carmen and Margarita islands and the Gulf coast of the peninsula."

I figured a specimen labelled "Lower California" as var. *striatulus* in Manual of Conchology XI, p. 143, pl. 19, figs. 50, 68,²⁶ accepting J. G. Cooper's identification of *striatulus* as identical with his race from the Sierra El Taste, called var. *vegexpiza*²⁷ (so named because it "has characters like *B. vegetus*, *B. excelsus*, *B. spirifer* and *B. montezuma*"!). This shell has sculpture substantially as in the type of *B. p. striatulus*.

Hanna²⁸ mentioned *B. striatulus* as occurring on Margarita Island, having been misled by Dall's mention of that locality. The Margarita Island specimens never have sculpture "comparable to the surface of *B. montezuma*"—the only character mentioned by Dall. Also they differ decidedly in color (*striatulus* and "*vegexpiza*" being white), as well as in shape and peristome.

The type specimen of *B. p. striatulus* is No. 58652 U. S. N. M., from the R. E. C. Stearns collection, kindly lent me by Dr. Bartsch. It is said to be from Carmen Island, collector not known. Within the aperture "L. C." is pencilled. It is represented in Pl. 12, fig. 8, the sculpture of the last whorl in figs. 1, 7; length 42 mm.; diam. 24 mm.; length aperture 24 mm.; $6\frac{3}{4}$ whorls. The umbilicus is compressed and does not penetrate beyond the last whorl. There is a very dense, fine and low granulation, produced by the decussation of fine axial folds by many impressed spiral lines. At irregular intervals there are slightly emphasized spirals, as shown in fig. 1; but these are probably an individual rather than racial character. The greatest convexity of the last whorl is above the middle. The lip is white, well spread but not recurved at the margin, rather thick, and it is noticeably calloused at the inner edge. It is a fully adult or rather old individual. The margins of the peristome are somewhat chipped.

While not absolutely identical with "*vegexpiza*," which differs by having a decidedly *recurved* lip, the resemblance is so

²⁶ Fig. 68 represents the granulation as decidedly too emphatic; it is actually very low. The lithograph printed darker than was intended.

²⁷ Proc. Calif. Acad. Sci. (2), IV, p. 134, pl. 5, fig. 1; pl. 6, fig. 27.

²⁸ Proc. Calif. Acad. Sci. (4), XII, No. 26, p. 487.

great that I do not think two subspecies are likely to be maintained.

As to the assigned locality, Hanna doubts the occurrence of *striatulus* on Carmen Island, where the California Academy Expedition of 1921 worked well over the island and "collected almost 400 specimens of another species of *Bulimulus* but not one of the *montezuma* group." Stearns' specimen probably was wrongly localized, and really came from the mainland mountains.

We conclude, therefore, that *B. pallidior striatulus* is a race of the southern peninsular sierras, and strongly distinct specifically from *B. hannaï* of the Magdalena Bay region.

PUPILLIDÆ

25. *Pupilla sterkiana* (Pilsbry)

Pupa sterkiana PILSBRY, Proc. A. N. S. Phila. 1889, p. 411, pl. 2, figs. 2, 3.
Pupilla sterkiana PILSBRY, Man. Conch., (2) XXVI, p. 156, pl. 19, figs. 16, 17 (San Ramon, Lower California).

San Martin Island (G. D. Hanna).

A few beautiful albino shells were taken among many of the normal brown color.

26. *Vertigo californica diegoensis* (Sterki)

San Quintin Bay, west shore; San Martin Island (G. D. Hanna).

Typical specimens; at the first locality only one old shell with *Sterkia hemphilli* (St.).

27. *Sterkia calamitosa martiniana* Pilsbry, new subspecies

Plate 12, figure 2

The shell is very similar to *S. calamitosa* but differs by the larger size and longer whorls, and the presence of a suprapalatal tubercle (rarely wanting).

Length 1.95 mm., diam. 0.9 mm.; fully 5 whorls. Holotype.

Length 1.75 mm., diam. 0.9 mm.; 5 whorls. Paratype.

Length 1.60 mm., diam. 0.9 mm.; smallest specimen.

Holotype: No. 2626, *paratype* No. 2627, Mus. Calif. Acad. Sci., from **San Martin Island, Lower California**; under stones and among plant debris; G. D. Hanna, collector.

There are a few beautiful albino examples in the lot. While very close to mainland *calamitosa*, the small differences seem to indicate a slightly differentiated insular race.

28. *Sterkia hemphilli* (Sterki)

San Quintin Bay, west shore (G. D. Hanna).

TRUNCATELLIDÆ

29. *Truncatella stimpsoni* Stearns

Plate 7, figures 10, 12-14

San Martin Island, Lower California, collected by Dr. Fred Baker, August, 1899.

One of this lot is illustrated, fig. 10. Other specimens from San Diego, the type locality, appear in figs. 12, 13 and 14, the last a very fine-ribbed form.

30. *Truncatella californica* Pfr.

San Martin Island with the preceding (Dr. Fred Baker).

The specimens are almost smooth but show faint traces of ribs. While the two forms *californica* and *stimpsoni* are generally separable without difficulty, there appear to be a few intermediate specimens, such as the very finely ribbed shell from San Diego shown in Pl. 7, fig. 14, having about twice as many ribs as *T. stimpsoni*. The known range of *T. californica*

and *T. stimpsoni* is the same—San Diego, California, to San Martin Island, L. C.

These Truncatellæ were not taken by the expedition of 1922, but are included as giving a new southern limit for both.

AMNICOLIDÆ

31. *Paludestrina cedrosensis* Pilsbry, new species

Text figures 3a, b, c

The shell is openly perforate, conic with obtuse apex, thin, milky bluish and subtranslucent; smooth; composed of $3\frac{1}{2}$ strongly convex whorls, the last becoming shortly free in front. The aperture is broadly ovate, the continuous peristome thin and slightly dilated outwardly, the columellar margin expanded; columella evenly concave, slightly thickened.

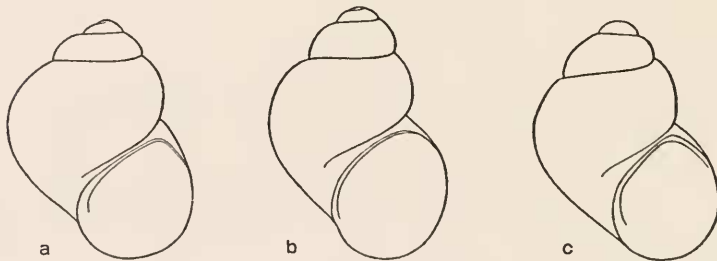


Fig. 3. *Paludestrina cedrosensis*.

Length 1.75 mm., diam. 1.35 mm., length of aperture 0.90 mm. Type, fig. 3c.
 Length 1.75 mm., diam. 1.35 mm., length of aperture 0.95 mm. Fig. 3b.
 Length 1.85 mm., diam. 1.30 mm., length of aperture 0.95 mm. Fig. 3a.

Holotype: No. 2628, *paratypes* Nos. 2629, 2630, from **Bernstein's Spring, Cedros Island, Lower California**; collected by G. D. Hanna, July, 1922.

The very thin yellowish operculum is retracted deep in the last whorl, out of sight in a front view in the aperture; nucleus

at the lower third of the length and the inner three-eighths of the width. Length, .8 mm.; width, .6 mm.

This little snail is more elongate than *Amnicola micrococcus* and shorter than *Paludestrina stearnsiana*; it appears to be related to the latter. It is the only fresh water mollusk known from Cedros Island. "Bernstein's Spring is the water supply for an abalone packing plant located at the mouth of the southernmost large cañon on the east side of the island. The spring is located inland about three miles, on the north side of the cañon and at an elevation of about 2500 feet." (G. D. H.).

PLATE 6

All figures approximately X 3

- Fig. 1. *Binneya notabilis* Cooper. No. 12204 (Acad. Nat. Sci. Philadelphia); Santa Barbara Island, Calif.; length, 13.3 mm.
- Figs. 2, 4, 5. *Binneya guadalupensis* Pilsbry, n. sp. Nos. 2566-2570 (C.A.S.); Guadalupe Island, Lower California, three miles south of Northeast Anchorage; lengths, 11.2, 10.5 and 4.5 mm. Holotype, No. 2566.
- Figs. 3, 6. *Binneya guadalupensis* Pilsbry, n. sp. Dormant specimens showing the white epiphragm which envelops non-retracted parts of the animal; Guadalupe Island, same location as above; lengths of shells, 8.7 and 6.3 mm.
- Figs. 7, 8, 9. *Binneya guadalupensis* Pilsbry, n. sp. Alcoholic specimens, Nos. 2571-2573 (C.A.S.), with shells removed; fig. 9 is from a drowned individual; all from Pine Ridge, Guadalupe Island, Lower California; elevation 3000 feet.
- Fig. 10. *Micrarionta areolata* (Pfeiffer). Pallial organs.

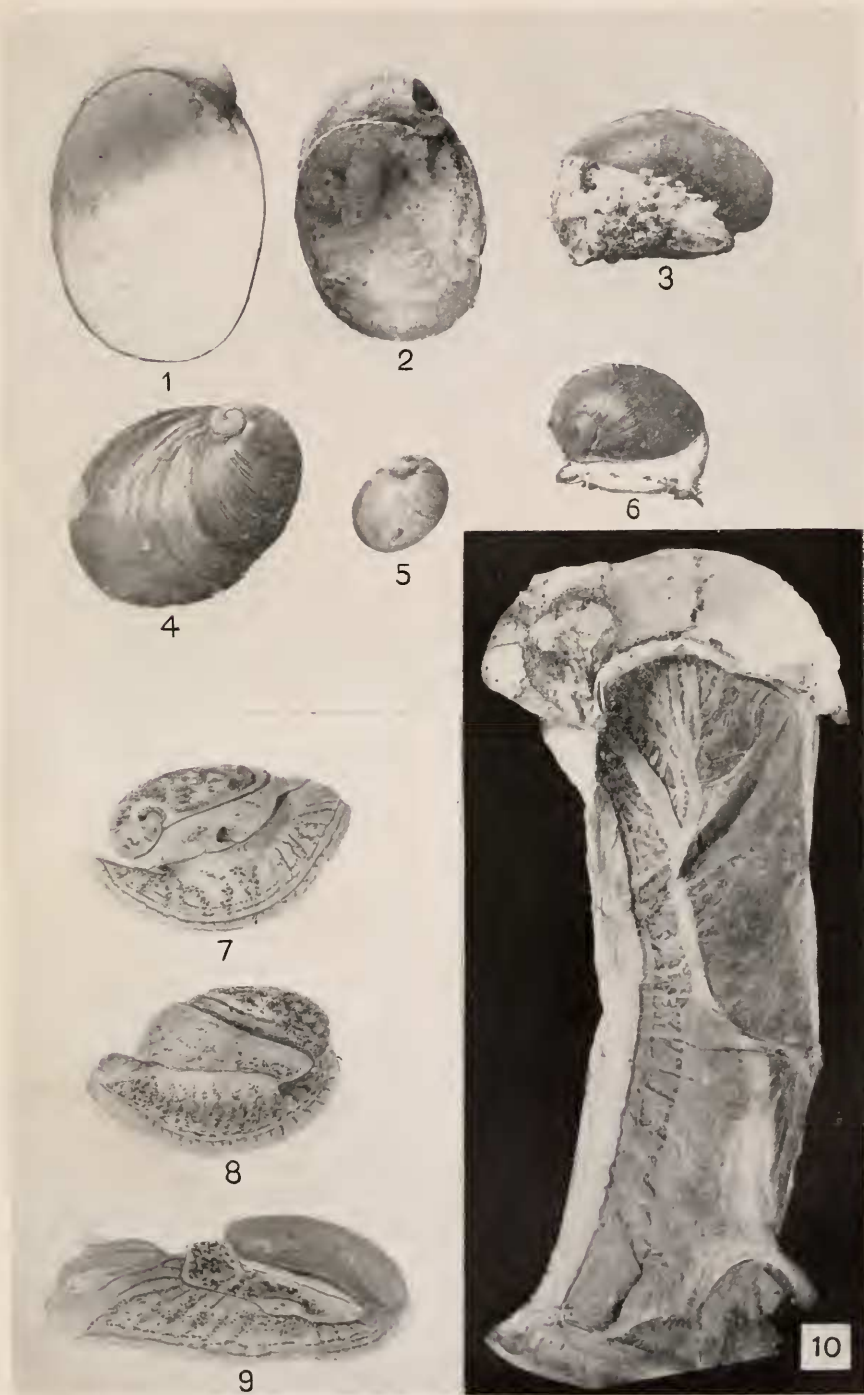


PLATE 7

- Fig. 1. *Pupilla guadalupensis* Pilsbry, n. sp. Holotype, No. 2575 (C.A.S.) from 1000 feet above Northeast Anchorage, Guadalupe Island, Lower California; length, 2.8 mm.
- Fig. 2. *Pupilla guadalupensis* Pilsbry, n. sp. Paratype (toothless form), No. 2579 (C.A.S.) from two miles north of south end of Guadalupe Island, Lower California; length, 3.1 mm.
- Fig. 3. *Pupilla goniodon* Pilsbry, n. sp. Holotype, No. 2574 (C.A.S.) from Northeast Anchorage, Guadalupe Island, Lower California; length, 4.0 mm.
- Fig. 4. *Vertigo californica guadalupensis* Pilsbry, n. ssp. Holotype, No. 2582 (C.A.S.) from 1000 feet above Northeast Anchorage, Guadalupe Island, Lower California; length, 2.0 mm.
- Fig. 5. *Vertigo californica catalinaria* Sterki. Plesiotype, No. 2581 (C.A.S.) from 1000 feet above Northeast Anchorage, Guadalupe Island, Lower California; length, 1.9 mm.
- Fig. 6. *Vertigo degeneris* Pilsbry, n. sp. Holotype, No. 2583 (C.A.S.) from 1000 feet above Northeast Anchorage, Guadalupe Island, Lower California; length, 1.9 mm.
- Figs. 7, 7a. *Haplotrema guadalupensis* Pilsbry, n. sp. Holotype, No. 2566 (C.A.S.) from Pine Ridge, Guadalupe Island, Lower California; elevation 3000 feet; diameter, 4.9 mm.
- Fig. 8. *Helminthoglypta hannai* Pilsbry, n. sp. Paratype, No. 2561 (C.A.S.), small depressed form; from Pine Ridge, Guadalupe Island, Lower California; diameter, 17.0 mm.
- Figs. 9, 9a, 9b. *Helminthoglypta hannai* Pilsbry, n. sp. Holotype, No. 2560 (C.A.S.) from Pine Ridge, Guadalupe Island, Lower California; diameter, 20.6 mm.
- Fig. 10. *Truncatella stimpsoni* Stearns. No. 82436 (Acad. Nat. Sci. Philadelphia) from San Martin Island, Lower California.
- Fig. 11. *Truncatella guadalupensis* Pilsbry. Figure on right is the type, No. 81973 (Acad. Nat. Sci. Phila.) from Guadalupe Island, Lower California.
- Fig. 12-14. *Truncatella stimpsoni* Stearns. Nos. 10553 and 117903 (Acad. Nat. Sci., Phila.) from San Diego, California.

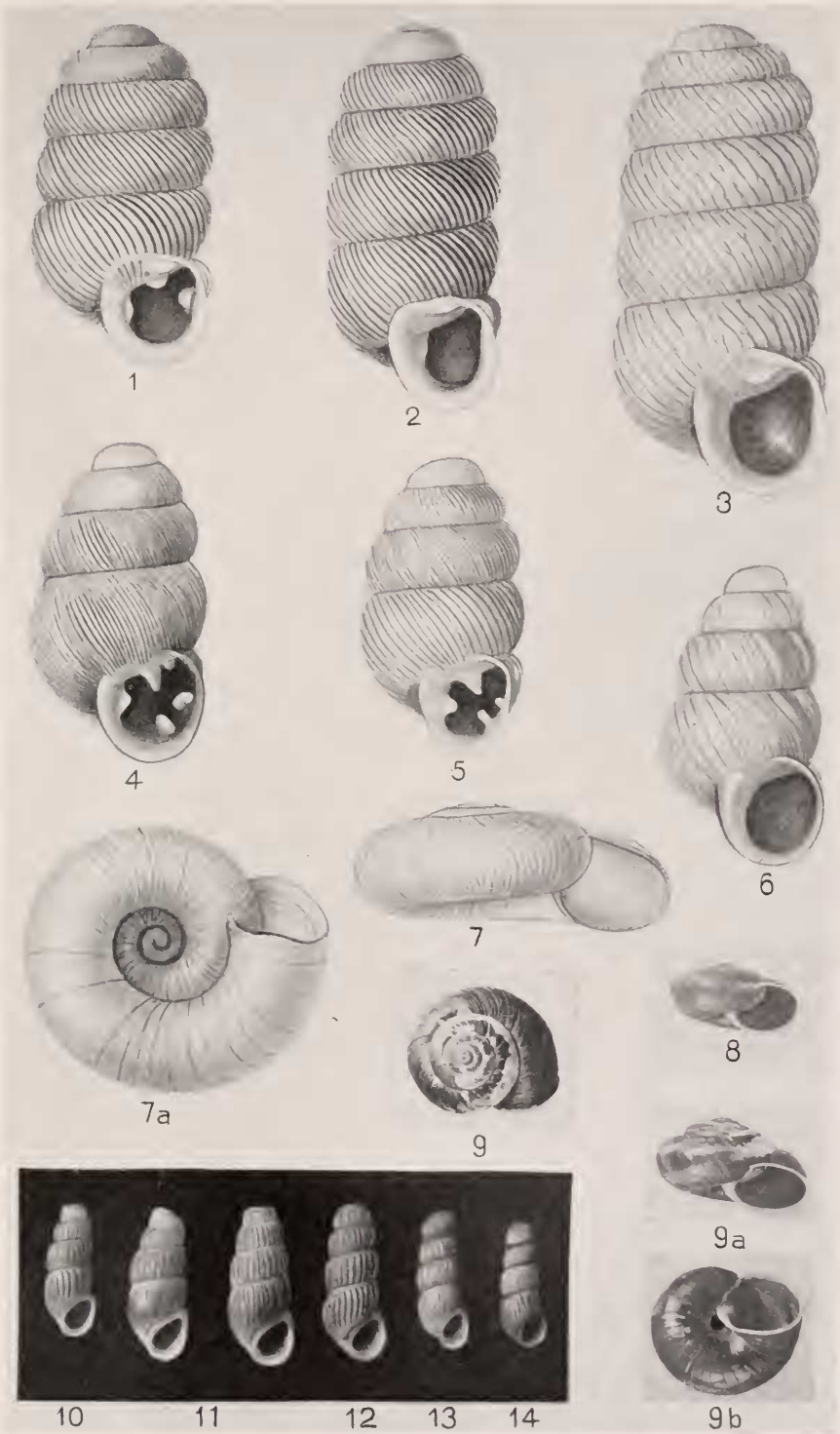


PLATE 8

Fig. 1. *Micrarionta guadalupiana*; reproductive system of specimen from near Northeast Anchorage, Guadalupe Island, Lower California.

Fig. 1a. The same from below.

Fig. 2. *Micrarionta facta*; reproductive system; Santa Barbara Island, California.

Fig. 3. *Micrarionta guadalupiana*; reproductive system of paratype.

Fig. 3a. Section of the uterus of same at the point indicated by arrow.

Fig. 3b. Jaw of *Micrarionta guadalupiana*. Paratype.

a.m.g., ascending mucus gland. *d.m.g.*, descending mucus gland. *d.s.*, dart sac. *fl.*, flagellum. *sp.*, spermatheca. *sp.d.*, duct of spermatheca.

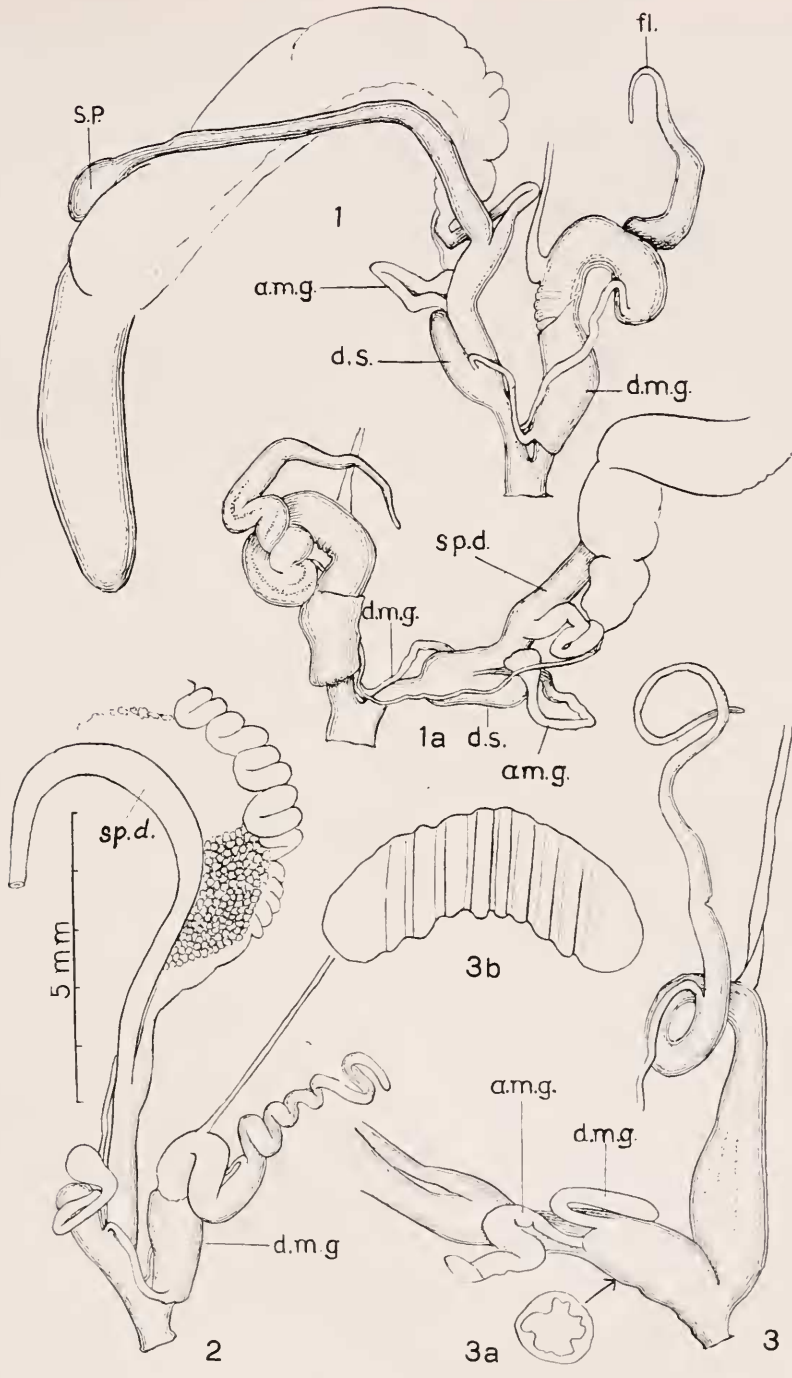


PLATE 9

Fig. 1. *Micrarionta arcolata*; reproductive system of specimen from near the village of Magdalena Bay.

Fig. 1a. Detail of dart sac and associated parts, from below.

Fig. 1b. Penis, with the flagellum partly uncoiled.

Fig. 2. *Binneya guadalupensis*; lower part of the reproductive system.

Fig. 2a. Penis with the epiphallus partly pulled out.

Fig. 2b. Atrium and vagina spread open, showing the projecting lower part of the oviduct, and at 0 the opening of the spermathecal duct.

Figs. 2c, 2d. Sections of the oviduct cut at the points marked *a-b* and *c-d* respectively.

Fig. 3. Jaw of *B. guadalupensis*.

a.m.g., ascending mucus gland. *div.*, diverticulum of the spermathecal duct. *d.m.g.*, descending mucus gland. *d.s.*, dart sac. *epi.*, epiphallus. *fl.*, flagellum. *p.*, penis. *sp.*, spermatheca. *sp.d.*, duct of same.

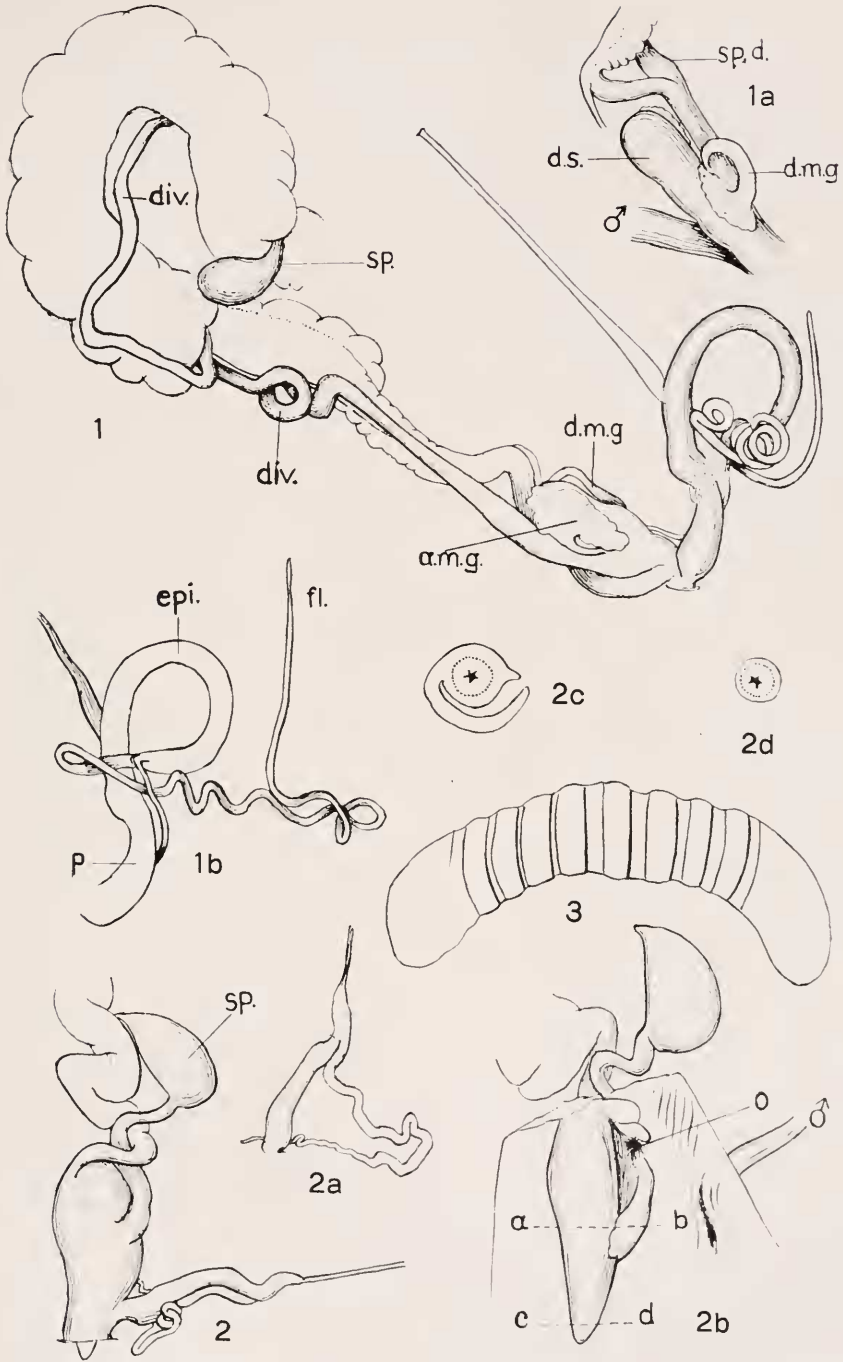


PLATE 10

- Figs. 1-9. *Micrarionta pandora* (Forbes). Plesiotypes, Nos. 2596-2604 (C.A.S.) from East Benito Island, Lower California.
- Figs. 10-12. *Micrarionta pandora* (Forbes). Plesiotypes, Nos. 2605-2607 (C.A.S.) from south side of West Benito Island, Lower California.
- Figs. 13-16. *Micrarionta pandora* (Forbes). Plesiotypes, Nos. 2608-2611 (C.A.S.) from north side of West Benito Island, Lower California.
- Figs. 17-22. *Micrarionta levis crassula* (Dall). Plesiotypes, Nos. 2612-2617 (C.A.S.) from Natividad Island, Lower California.
- Figs. 23-26. *Helminthoglypta hannai diodon* Pilsbry, n. ssp. Holotype (fig. 25), No. 2562, and paratypes, Nos. 2563-2565 (C.A.S.) from near Northeast Anchorage, Guadalupe Island, Lower California.

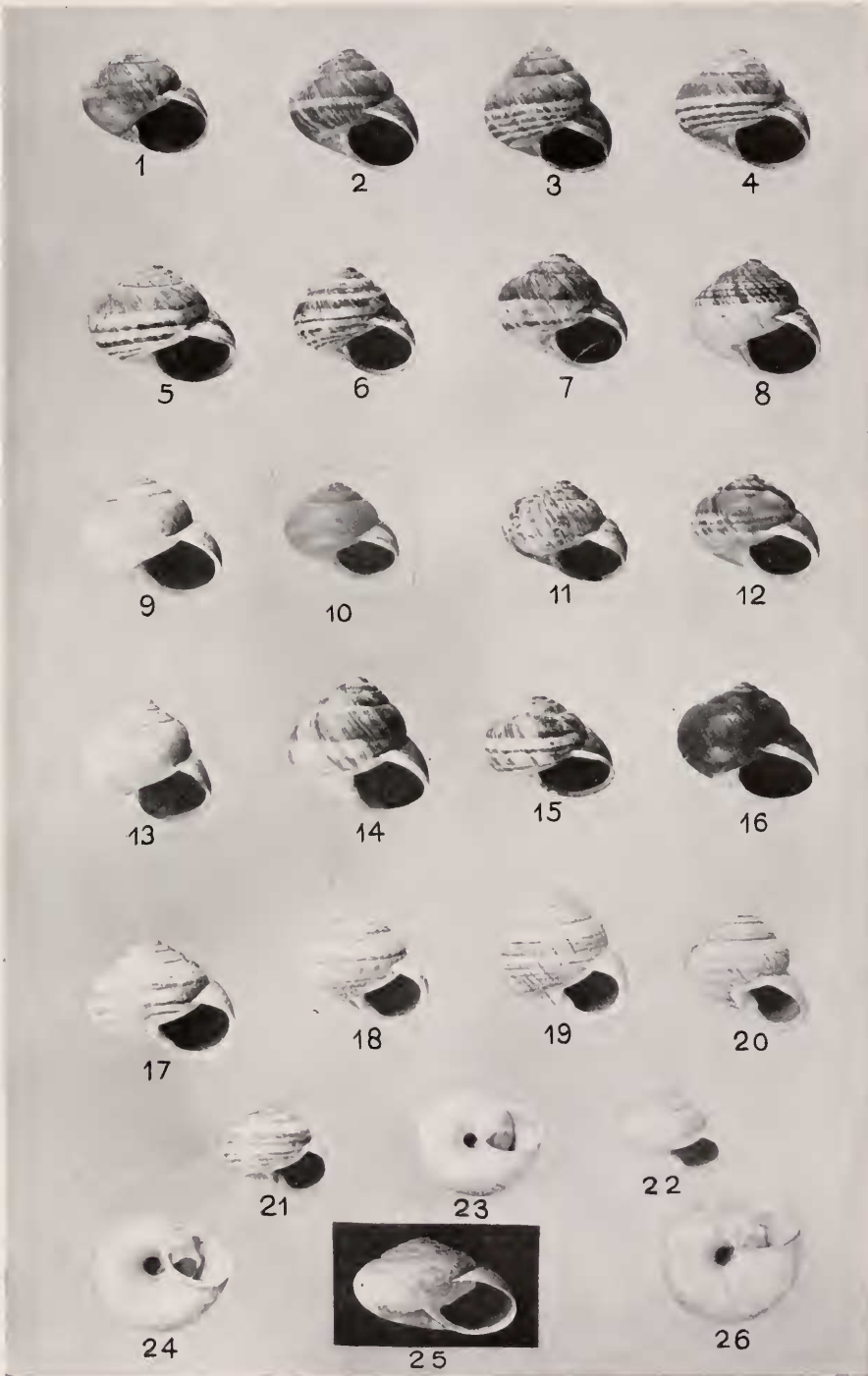


PLATE 11

- Fig. 1. *Micrarionta areolata* (Pfeiffer). Plesiotype, No. 2631 (C.A.S.) from southern division of Margarita Island, Magdalena Bay, Lower California.
- Fig. 2-5. *Micrarionta areolata* (Pfeiffer). Plesiotypes, Nos. 2632-2635 (C.A.S.) from near village of Magdalena Bay, Lower California; probably topotypes.
- Fig. 6. *Micrarionta canescens* (Adams & Reeve). Plesiotype, No. 2590 (C.A.S.) from Turtle Bay, Lower California.
- Figs. 7-10. *Micrarionta canescens* (Adams & Reeve). Plesiotypes, Nos. 2586-2589 (C.A.S.) from west side of Cedros Island, Lower California, near Red Rocks.
- Figs. 11-13. *Micrarionta canescens vetchii* ("Newcomb" Tryon). Plesiotypes, Nos. 2591-2593 (C.A.S.) from Cedros Island, Lower California; near Bernstein's Abalone Camp on southeast side of island.
- Figs. 14, 15. *Micrarionta canescens vetchii* ("Newcomb" Tryon). Plesiotypes, Nos. 2594-2595 (C.A.S.) from South Bay, Cedros Island, Lower California.
- Figs. 16-20. *Bulimulus hannaï* Pilsbry, n. sp. Holotype (fig. 19), No. 2621, and paratypes, Nos. 2622-2625 (C.A.S.) from Margarita Island in Magdalena Bay, Lower California; from about one mile southwest of settlement on east side of island, near center.

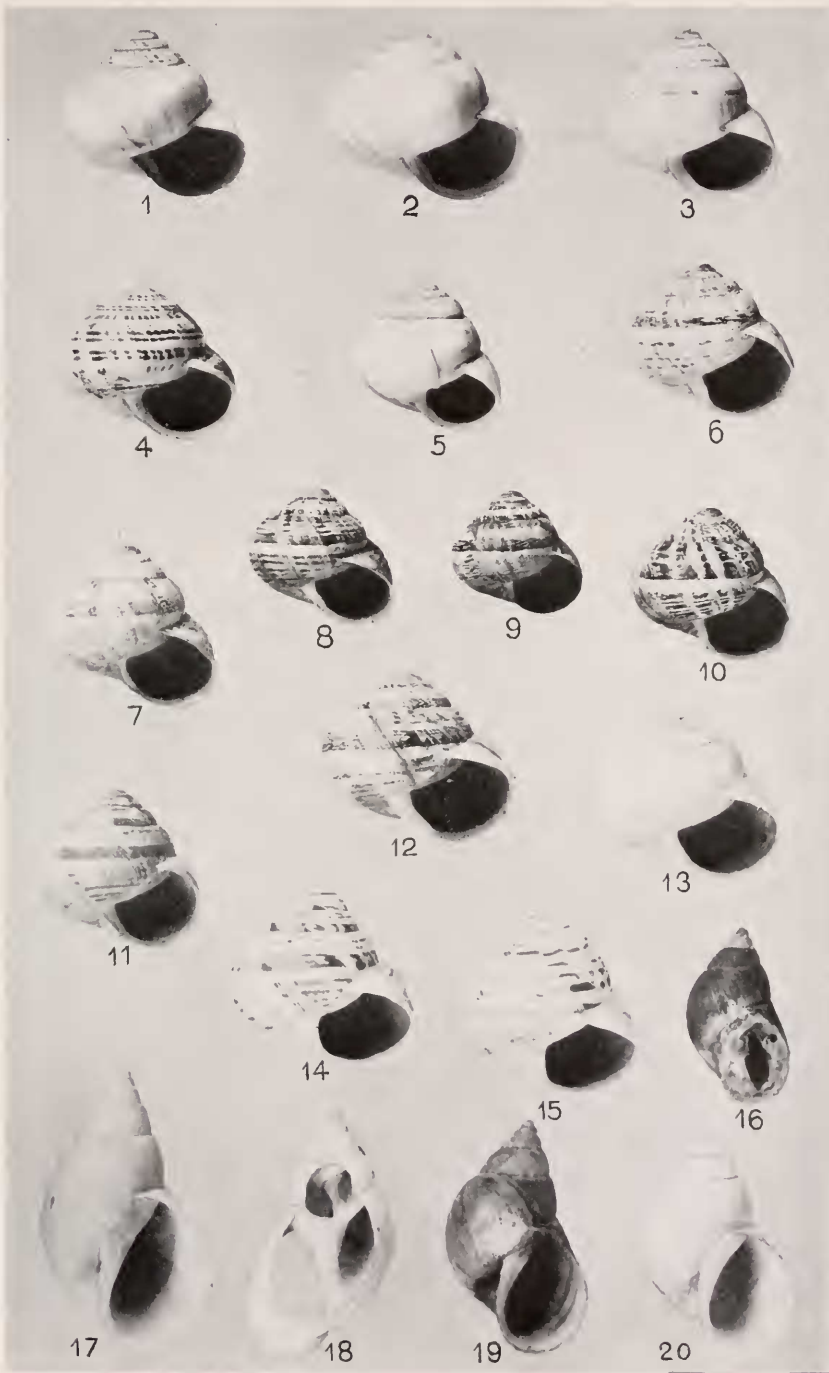
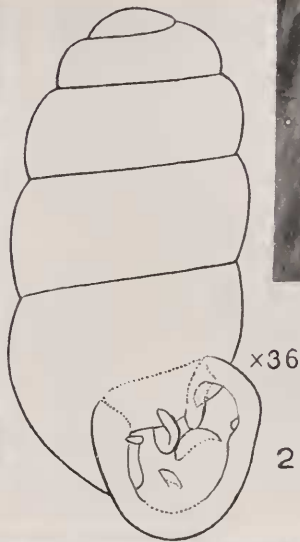


PLATE 12

- Fig. 1. *Bulimulus pallidior striatulus* Dall. Showing sculpture of last whorl of holotype, No. 58052 (U. S. Nat. Mus.) from mountain district of Lower California, probably.
- Fig. 2. *Sterkia calamitosa martiniana* Pilsbry, n. ssp. Holotype, No. 2626 (C.A.S.) from San Martin Island, Lower California.
- Fig. 3. *Bulimulus hannai* Pilsbry, n. sp. Sculpture ($\times 10$) of portion of base of holotype, No. 2621 (C.A.S.) from Margarita Island in Magdalena Bay, Lower California.
- Figs. 4-6. *Micrarionta evermanni* Pilsbry, n. sp. Holotype, (figs. 4, 5), No. 2618, and paratype, No. 2619 (C.A.S.) from north side of Turtle Bay, Lower California.
- Fig. 7. *Bulimulus pallidior striatulus* Dall. Sculpture of left side of last whorl of holotype ($\times 6$, approximately) No. 58052 (U. S. Nat. Mus.).
- Fig. 8. *Bulimulus pallidior striatulus* Dall. Holotype, No. 58052 (U. S. Nat. Mus.) probably from mountain district of Lower California.



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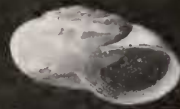
2



3



4



5



6



5 mm

7



8